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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/749,022	12/30/2003	Sang Kyun Park	29936/39889	9225
4743	7590	01/24/2005	EXAMINER	
MARSHALL, GERSTEIN & BORUN LLP 6300 SEARS TOWER 233 S. WACKER DRIVE CHICAGO, IL 60606			GURLEY, LYNNE ANN	
			ART UNIT	PAPER NUMBER
			2812	

DATE MAILED: 01/24/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

H-A

Office Action Summary

Application No.

10/749,022

Applicant(s)

PARK, SANG KYUN

Examiner

Lynne A. Gurley

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 10 November 2004.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3-13 and 15-25 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3-13 and 15-25 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.


Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.


LYNNE A. GURLEY
PRIMARY PATENT EXAMINER
TC 2800, AU 2812

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

This Office Action is in response to the amendment filed 11/10/04.

Currently, claims 1, 3-13 and 15-25 are pending.

Specification

1. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1, 7, 13, 19, 21-22 and 24 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Wang et al. (US 6,387,806, dated 5/14/02).
4. Wang shows the method as claimed in figures 1-19 and corresponding text, with emphasis on figures 14-15, to show the recess 228 formed by CMP, which produces a surface of the copper wiring 230 lower than the surface of the interlayer insulating film 204. Wang shows the substrate 206, interlayer insulating film 204 with damascene

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pattern and copper anti-diffusion conductive film 212 and copper layer 230 with the recess 228 (fig. 14) formed by CMP (column 9, lines 9-34), and copper anti-diffusion insulating film or conducting film (additional encapsulating material 222 in fig. 13 SiON, SiN, SiC, metal oxide and/or metal dopant (column 4, lines 20-36; column 7, lines 45-67; column 8, lines 1-54). The metal dopant is deposited with the copper fill by electroless plating.

5. Claims 13, 15, 19, 21, 23 and 25 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Saito et al. (US 2003/0109129, dated 6/12/03, filed 12/27/02).

6. Saito shows the method as claimed in figures 1-38 and corresponding text, with emphasis on figures 3-7, with damascene pattern HM1 (fig. 3) in interlayer insulating film 22; copper anti-diffusion conductive film M1a/M1b (fig. 4); copper wiring M1c by CMP (fig. 5), wherein the surface of the copper wiring is lower than the surface of the interlayer insulating film (slight dishing shown in fig. 5, [0107]-[0108]); selective formation of a copper anti-diffusion conductive film CM1 (fig. 6; selective deposition of W; [0109]) on the top surface of the copper wiring. Saito shows that the copper wiring is annealed after the CMP step in a reducing atmosphere [0108]. The CMP process may be performed to concave the top surface of the copper wiring and then an annealing process is performed before and during the deposition of the selective W which will convex the surface, even if only relatively to the concave surface resulting from the CMP [0108]-[0110], [0112] (especially [0110], line 11-18). Cleaning is performed [0113]-[0114]. Heat treatment is performed in a reducing atmosphere with hydrogen or ammonia [0108], [0133] – also includes plasma, [0151]. Other cleaning solutions may be used [0114].

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

9. Claims 16-18, 20, 22 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saito et al. (US 2003/0109129, dated 6/12/03, filed 12/27/02).

10. Saito shows the method substantially as claimed and as described in the preceding paragraphs.

11. Saito lacks anticipation only in not teaching that; 1) nitric acid for the cleaning process so that the copper wiring is further lower than the surface of the interlayer insulating film; 2) the annealing process is performed using a temperature of 100-500 degrees C or 200-700 degrees C for 1 to 5 minutes in a rapid thermal annealing process; 3) the plasma process is carried out in a temperature range of 100-350 degrees C; and, 4)

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the selective copper anti-diffusion conductive film is formed by selective electroless plating.

12. It would have been obvious to one of ordinary skill in the art to have used nitric acid for the cleaning process so that the copper wiring is further lower than the surface of the interlayer insulating film; to have performed the annealing process using a temperature of 100-500 degrees C or 200-700 degrees C for 1 to 5 minutes in a rapid thermal annealing process; to have carried out the plasma process in a temperature range of 100-350 degrees C; and, to have formed the selective copper anti-diffusion conductive film by selective electroless plating, in the method of Saito, with the motivation that: 1) nitric acid is an alternate conventional cleaning solution to the HF used in Saito, for post-CMP operations. These solutions are wet etchants of the surface of the metal, which is how they clean the surface, so that either HF or nitric acid would further recess the surface of the copper wiring layer (See Toyoda et al. [0124] or Gupta et al. (col.4, lines 44-50 for acid wet etch to further recess a copper wiring); 2) the anneal being in the claimed temperature range and using rapid thermal anneal is within a reasonable range of temperature for the substrate considering the subsequent selective deposition conditions and time constraints to make the process efficient; 3) the electroless plating method is a conventional alternative to the selective deposition method taught in Saito.

13. Claims 3-6, 8-12, 15-18, 20, 23 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang et al. (US 6,387,806, dated 5/14/02) in view of Noguchi (US 2003/0114000, dated 6/19/03, filed 11/14/02).

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14. Wang shows the method substantially as claimed and as described in the preceding paragraphs.

15. Wang lacks anticipation only in not teaching that; 1) a cleaning process is performed after the CMP step; 2) nitric acid for the cleaning process so that the copper wiring is further lower than the surface of the interlayer insulating film; 3) the annealing process is performed using a temperature of 100-500 degrees C or 200-700 degrees C for 1 to 5 minutes in a rapid thermal annealing process, both in an inert gas or a mixed inert gas; 4) the plasma process is carried out in hydrogen and nitrogen, ammonia or hydrogen and an inert gas in a temperature range of 100-350 degrees C; and 5) the copper anti-diffusion insulating film is formed by spin-on method and anneal in N₂, Ar, H₂ or He at 100 to 500 degrees C, using methyl, benzochlorobutane, polyimide, arylether and HSQ, which contain Si, C and N in a type of sol or gel.

16. Noguchi teaches, in a similar CMP process, a conventional post CMP cleaning step [0221] followed by an annealing step in H₂ [0222] to reduce the copper oxide formation on the surface of the copper wiring layer and an acid cleaning of the substrate [0223]-[0237]. Plasma treatment is also discussed.

17. It would have been obvious to one of ordinary skill in the art to have cleaned the copper surface after the CMP step; to have used nitric acid for the cleaning process so that the copper wiring is further lower than the surface of the interlayer insulating film; to have performed the annealing process using a temperature of 100-500 degrees C or 200-700 degrees C for 1 to 5 minutes, both in an inert gas or a mixed inert gas, in a rapid thermal annealing process; to have carried out the plasma process in hydrogen and nitrogen, ammonia or hydrogen and an inert gas in a temperature range of 100-350

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degrees C, in the method of Wang, with the motivation that: 1) cleaning after a CMP process in an acidic environment is conventional, as taught in Noguchi, and nitric acid is a conventional cleaning solution. Acid solutions are wet etchants of the surface of the metal, which is how they clean the surface, so that nitric acid would further recess the surface of the copper wiring layer (See Toyoda et al. [0124] or Gupta et al. (col.4, lines 44-50 for acid wet etch to further recess a copper wiring); 2) the anneal, being in the claimed temperature range and using rapid thermal anneal, is within a reasonable range of temperature for the substrate considering the subsequent selective deposition conditions and time constraints to make the process efficient and considering the annealing/plasma parameters taught in Noguchi, as well as the anneal in H₂, ammonia and N₂ atmospheres taught in Noguchi in order to reduce the copper oxide formation, making the device more reliable.

18. It would have also been obvious to one of ordinary skill in the art to have formed the copper anti-diffusion insulating film by spin-on method and anneal in N₂, Ar, H₂ or He at 100 to 500 degrees C, using methyl, benzochlorobutane, polyimide, arylether and HSQ, which contain Si, C and N in a type of sol or gel, in the method of Wang, with the motivation that these are conventional passivation/diffusion layers, alternatives to the insulating passivation/diffusion layers taught in both Wang and Noguchi.

Response to Arguments

19. Applicant's arguments filed 11/10/05 have been fully considered but they are not persuasive. In response to Applicant's remarks, pages 14-15, regarding the Wang reference, the "polished down" process, as Applicant refers to it, is a CMP process

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(column 9, lines 15-18). Also, the anneal in Wang is one part of the process which includes the Cu alloy 232 fill to make the surface convex. The “comprising” language in the claim allows for the additional step of depositing the Cu alloy fill 232. Thus, the claim language does not preclude the additional step of filling with the Cu alloy.

20. In response to Applicant’s remarks, page 15, regarding the Wang reference, avoiding the problem of electro-migration and stress migration at a junction of the copper wiring 244 and the encapsulating film 22 is not claimed.

21. In response to Applicant’s remarks, pages 16-18, regarding the Saito reference, Saito teaches dishing the copper surface, which results from the CMP step to planarize the copper, throughout the text of the patent. See figures 5-6, [0109] – [0110], especially the last 8 lines of page 6 of the patent in [0110]. The annealing step forms the W layer CM1 in figure 6, which also makes the concave portion of the Cu plug, convex..

Conclusion

22. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the

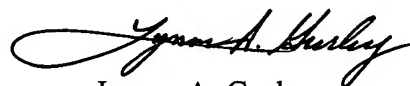
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shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lynne A. Gurley whose telephone number is 571-272-1670. The examiner can normally be reached on M-F 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling can be reached on 571-272-1679. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Lynne A. Gurley
Primary Patent Examiner
TC 2800, Art Unit 2812

LAG
January 18, 2005